Adolescence, Brain Development and Vulnerability to Alcohol



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Implications of New Research

- Adolescence is a period of profound brain maturation.
- We *thought* brain development was complete by adolescence.
- We now know... maturation is not complete until about <u>age 25!!!</u>



Allstate Insurance ad, *NY Times,* May, 2007

Brain Development Research

- From ages 13 to about age 25, a pruning and strengthening process is happening in adolescent brains.
- During that time, the brain cells and neural connections that get used the least get pruned away and die off.
- Those that get used the most get stronger.



Source: PHAS USA 2004 May 25; 101(21): 8174-8179. Epub 2004 May 17.

Construction Ahead



 When the "pruning" is complete, the brain is faster and more efficient.

 But... during the pruning process, the brain is not functioning at full capacity.



Maturation Occurs from Back to Front of the Brain (Ages 5 – 25)

Earlier maturation:Motor Coordination

Emotion

Later maturation:Motivation

Later maturation:Judgment



Maturation Occurs from Back to Front of the Brain (Ages 5 – 25)

Nucleus acumbens, motivation Direction of Brain Development Prefrontal Amygdala, emotion Corpus callosum cortex, judgment Basal ganglia Cerebellum Cerebellum, physical coordination

Seven Implications of Brain Development for Adolescent Behavior

Preference for...

- **1.** Physical activity
- 2. High excitement and low effort activities
- 3. Activities with peers that trigger high intensity/arousal
- 4. Novelty

Less than optimal...

- 5. Balance of emotion and logic when making decisions
- 6. Consideration of negative consequences

Greater tendency to...

7. Take risks and show impulsiveness

An Immature Brain = Less Brakes on the "Go" System



An Immature Brain ≠ Low Brain Power



An Immature Brain ≠ Absence of *A*// Judgment



(Note harness)

And a mature brain does not always mean a powerful one...



Judgment Gets Better With Age

- By age 18, the adolescent's judgement for structured challenges is roughly equal to that of an adult's.
- However, it is not yet equivalent for decisions that require <u>resisting impulses</u> <u>or delaying gratification</u>.

1. Brain development

2. Developing brain & alcohol risk



Seven Implications of Brain Development and Adolescent Behavior on Alcohol Use

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- 1. Physical activity
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- 4. Novelty
- Less than optimal...
 - 5. Balance of emotion and logic when making decisions
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Greater tendency to...

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Implications of Adolescent Brain Development on Alcohol Abuse Vulnerability

Are adolescents more susceptible than adults to <u>alcohol's effects</u>?

4 Lines of Evidence



It is unethical to give human adolescents alcohol in the laboratory. Much of the best evidence comes from adolescent rat studies. Supporting evidence on alcohol sensitivity from animal models needs to be interpreted with prudence.

Implications of Adolescent Brain Development on Alcohol Abuse Vulnerability

1. Evidence from epidemiological studies

1. Past Year Alcohol Use Disorder (Abuse or Dependence) Among Adults Aged 21 or Older, by Age of First Use (SAMHSA, 2005)



Age Started Drinking

Are adolescents more susceptible to alcohol than adults?

1. Epidemiological data

Comparing adolescent and adult rats, both with no prior exposure to alcohol and matched on temperament....

- 2. Adolescent rats are <u>less sensitive</u> to the sedative and motor impairment effects of <u>intoxication</u>.
 - They drink more before brain "signals to stop."



2. Survey Data Suggest that Adolescents Are Less Sensitive to Alcohol's Effects (Monitoring the Future Youth Survey, 2001)



Are adolescents more susceptible to alcohol than adults?

- 1. Epidemiological data
- 2. Adolescent rats are <u>less sensitive</u> to the sedative and motor impairment effects of <u>intoxication</u>.



- **3.** Adolescent rats are <u>more sensitive</u> to the social disinhibition effects of alcohol.
 - Experience greater social comfort from intoxication



Are adolescents more susceptible to alcohol than adults?

1. Epidemiological data

- 2. Adolescent rats are <u>less sensitive</u> to the sedative and motor impairment effects of <u>intoxication.</u>
- **3.** Adolescent rats are <u>more sensitive</u> to the social disinhibition effects of alcohol.

#2 and **#3** : May contribute to binge drinking and increased risk to alcohol dependence.

2. & 3. Binge Alcohol Use in the Past Month, by Age Group (saмнsa, 2005)



Binge = 5+ drinks same occasion on at least one day in the past 30 days.

Are adolescents more susceptible to alcohol than adults?

- 1. Epidemiological evidence
- 2. Adolescent rats are <u>less sensitive</u> to the sedative and motor impairment effects of <u>intoxication</u>.
- 3. Adolescent rats are <u>more sensitive</u> to the social disinhibition effects of alcohol.

4. Alcohol may produce <u>greater</u> <u>cognitive disruptions</u> in adolescents.

Animal Data: Alcohol's Effects

- 4. Adolescent rats more sensitive to..
 - disruption in memory
 - impairment of neurotransmission in hippocampus (memory region)
 and cortex



nere is

4. Alcohol's Effects on Cognitive Skills of Adolescents **(Source: Brown et al., 2000)**



information

information

Retention Rate %

Human Data: Alcohol's Effects

4. Adolescents with a history of alcohol use disorder....

Hippocampus volume (10%)

Hippocampus converts information to memory

Where is my iPod?

Source: Tapert & Schweinsburg, 2005

"Priming the Pump" Theory

 Does early exposure to drugs/alcohol alter the brain in ways that contribute to the addiction process in ways that are unique to youth?



Average Number of Self-Administered Doses of Nicotine, by Age of First Exposure in Adult Rats (Levin et al., 2003)



Age of Rates When First Exposed to Nicotine



Summary

- Adolescence is an extended period of transition from reliance on adults to independence.
- Normal adolescence is characterized by....
 - increase in conflicts with family members
 - desire to be with one's friends
 - resistance to messages from authority
 - irritability
 - risk taking
 - proclamations of sheer boredom



- The brain undergoes a considerable amount of development during the teen years.
- The last area to develop is the prefrontal cortex, which is involved in planning, decision making and impulse control.



 Several lines of evidence suggesting that adolescents are more vulnerable to the effects of alcohol than adults.

 The mechanisms for why the developing brain is more susceptible are not yet completely understood.

Implications for Prevention & Treatment Programs

Prevention take home:

 Every year use of alcohol is delayed, the risk of developing alcohol abuse is reduced.

Treatment take home:

 Treating alcohol abuse in young people can reduce likelihood of later addiction, and possible (further) neurological and cognitive damage.

Take Home Summary

- P = <u>Promote</u> activities that capitalize on the strengths of the developing brain.
- A = Assist children with challenges that require planning.
- R = <u>Reinforce</u> their seeking advice from adults; teach decision making.
- **E** = <u>Encourage</u> lifestyle that promotes good brain development.
- N = <u>Never</u> underestimate the effects of alcohol on the developing brain.
- = <u>Tolerate</u> the "oops" behaviors due to an immature brain.



Suggested Resources

A Parent's Guide to the Teen Brain http://www.drugfree.org/teenbrain

Maine Parents http://www.maineparents.net/

Frontline: Inside the Teenage Brain

http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/view/

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